A compilation of

Scientific Information on

Nabugabo Ramsar Site, Uganda

Proceedings of the Scientific Conference held at Nabugabo in January, 2001

Edited by:

Busulwa H., P. G. Mafabi and L. M. Ndawula

2005

NABUGABO LAKES AND THEIR CURRENT CONSERVATION STATUS

Namulemo Gertrude and Dismas Mbabazi,
National Agricultural Research Organization, Fisheries Resources Research Institute, P. O. Box 343, Jinja.

Abstract

Fish species diversity in Lake Nabugabo, Uganda, has declined following establishment of the introduced fish species in the lake. Most of the native fish species have disappeared and the lake is now dominated by the introduced Nile perch, *Lates niloticus* and the Nile tilapia *Oreochromis niloticus*. The dominant native fish species include *Synodontis afrofischeri*, *Schilbe intermedius*, *Rastrineobola argentea* and *Brycinus sadleri*. Some of the native fish species that have disappeared from Lake Nabugabo were reported to occur in lakes Kayugi and Kayanja, which are adjacent to Lake Nabugabo but separated from it by extensive papyrus swamps. The Nabugabo lakes are satellite water bodies in the Lake Victoria basin, which is known to have experienced fish species changes due to the introduction of the Nile perch *Lates niloticus* during the 1960s. The Nabugabo lakes comprising of Lake Nabugabo main, and the smaller lakes Kayanja and Kayugi were investigated between 2000 and 2002 with experimental gillnetting to evaluate the potential of these lakes in conservation of fish species diversity. Results show that some native fish species especially *Oreochromis esculentus*, and *Oreochromis variabilis* and the haplochromine cichlid Prognathochromis venator that have disappeared from Lake Nabugabo still occur in Lakes Kayanja and Kayugi. Inshore habitats with macrophyte cover were also found to be important habitats for the endangered native fish species in the Nabugabo lakes. These lakes and inshore habitats need to be protected to conserve the endangered native fish species and to reduce further decline in fish species diversity.

Keywords: Conservation, fish species, refugia

Introduction

Fish species diversity and water quality in the East African great lakes are now critically threatened by human impacts (Kaufman, 1993). The Lake Victoria system was the first to show collapsing fisheries, wholesale loss of fish species diversity and lake-wide environmental degradation. Decline in fish species diversity has been attributed to over-fishing, the introduction of non-native species, deleterious land use practices and pollution from various sources. Over 50% of the endemic fishes disappeared from Lake Victoria between 1980 and 1986 and many are presumed extinct (Kaufman, 1992). Predation by the introduced Nile perch *Lates niloticus* is reported to have been a major contribution to the mass extinction of the native fish species (Ogutu-Ohwayo, 1993). Similar changes have occurred with the introduction of Nile perch into other lakes in the region e.g. Lakes Kyoga and Nabugabo.

As in the case of lakes Victoria and Kyoga, the introduction of Nile perch and several tilapiines into Lake Nabugabo in 1960 (Ogutu-Ohwayo, 1993) was accompanied by disappearance of many of the native fish species from the lake. A survey carried out in Lake Nabugabo in 1991 and 1992 revealed that of the species that formed the basis of the pre-perch commercial fishery, (*O. esculentus*, *O. variabilis*, and *Bagrus docmak*) were absent while *Schilbe intermedius*, *Clarias gariepinus* and *Protopterus aethiopicus* were rare (Ogutu-Ohwayo, 1993). However, lakes Kayanja, Kayugi and Manywa, which are adjacent to Lake Nabugabo but separated from it by extensive swamps, still contain some of the native fish species that have disappeared from Lake Nabugabo (Ogutu-Ohwayo, 1993).

Loss of biodiversity in the Lake Victoria basin has led to a series of studies directed at the identification of faunal refugia (Kaufman, 1993). Two major types of biodiversity refugia in lakes harbouring introduced Nile perch are recognized: refugia outside the lakes (satellite lakes and associated wetlands) and refugia within the lakes (wetlands and rocky shores, Chapman in press.). In this study, a cluster of water bodies referred to as the Nabugabo lakes was investigated between 2000 and 2002 with a major objective of determining the potential of Nabugabo lakes in conservation of fish species diversity.

Study area

Three lakes were sampled namely, Nabugabo, Kayanja, and Kayugi (Figure 1 on pg. 5). Lake Nabugabo is a small shallow open lake lying within an extensive swamp, which fills a former bay on the western shore of Lake Victoria. It has a length of five miles and a maximum width of three miles. Except for the western shore, the lake margin is swamp. It has a maximum depth of fifteen feet. The main inflows to Lake Nabugabo are River Juma and the Lwamunda swamp. The outflow of the lake is into Lake Victoria and is by seepage through the sand bar that forms the eastern barrier between the two lakes. In Lake Nabugabo, five sites, representing different habitat types, were sampled namely River mouth, “Dead duck” bay, Lubira, Campsite and Open water station.

Lake Kayugi has a maximum depth of about 3.0 m and an area of about 0.1km^2. A thick papyrus swamp that is connected to Lake Nabugabo via River Juma surrounds the lake and is fed by River Kagona from the northwest.

Lake Kayanja is not connected to Lake Nabugabo. It has a surface area of about 1.2 km^2 with a maximum depth of about 3.0 m. Apart from the eastern shoreline, the lake is surrounded by an extensive *Loudentia phragmitoides* dominated swamp. The swamp around this lake is fed by rivers Nsonzemu and Kikoma from the North-west and drains via River Kanwa eastwards, into Nakiga Bay of Lake Victoria

Materials and methods

Fish specimens were obtained from experimental gillnets set at various sites within the different lakes. Three graded fleets of gillnets, each consisting of nets of mesh size 25.4 mm to 305 mm stretched mesh at 12.7 mm intervals were used. The first fleet was set close to the shoreline, (inshore) the second was set approximately 20 m from the shoreline (midshore) and the third was set 200 m from the second fleet (offshore). All the fleets were set parallel to the shoreline. In Lake Kayugi only two fleets were used (inshore and open water) due to the small size of the lake. The nets were set at dusk, left overnight and retrieved the following morning. On retrieval, fish were sorted into taxonomic groups to species level whenever possible and the number and weight of each taxa in each mesh size of net recorded. Relative abundance of each species was calculated as a percentage of fish captured in each net at each site.

Results

Overall 18 fish taxa were recorded from the Nabugabo lakes as shown in Table 1. They included haplochromines, *Brycinus sadleri*, *Barbus kersternii*, *Barbus magdalenae*, *Gnathonemus longibarbis*, *Lates niloticus*, *Marcusenius grahami*, *Tilapia rendalii*, *Oreochromis leucostictus*, *Oreochromis esculentus*, *Oreochromis niloticus*, *Protopterus aethiopicus*, *Schilbe intermedius*, *Synodontis afrofischeri* and *Tilapia zillii*. The haplochromines included *Astatoreochromis alluaudi*, *Astatotilapia velifer*, *Astatotilapia nubila*, *Gaurochromis simpsoni*, *Paralabidochromis beadlei* and *Prognathochromis venator*.

Table 1. **Fish species composition in Lakes Nabugabo, Kayanja and Kayugi from 2000 to 2002. + = encountered, - = not encountered.**

Fish species	Nabugabo	Kayanja	Kayugi
Native species			
Afromastacembelus frenatus	+	-	-
Barbus kersternii	+	+	+
Barbus magdalenae	+	-	-
Brycinus sadleri	+	-	+
Clarias gariepinus	-	+	+
Clarias liocephalus	-	+	-
Gnathonemus longibarbis	+	-	-
Gnathonemus victoriae	+	+	+
Haplochromines	+	+	+
Marcusenius grahami	+	-	+
Oreochromis esculentus	-	+	+
Petrocephalus catastoma	+	+	+
Protopterus aethiopicus	+	+	+
Schilbe intermedius	+	-	-
Synodontis afrofischeri	+	-	-
Introduced species			
Lates niloticus	+	-	-
Oreochromis leucostictus	+	+	+
Oreochromis niloticus	+	-	-
Tilapia rendalii	+	-	-
Tilapia zillii	+	+	+
Total	**17**	**10**	**11**

Overall 13 fish taxa were recorded from L. Nabugabo (Table 2). They included haplochromines, *B. sadleri*, *B. kersternii*, *B. magdalenae*, *G. longibarbis*, *L. niloticus*, *M. grahami*, *O. rendalii*, *O. leucostictus*, *O. niloticus*, *P. aethiopicus*, *S. intermedius*, *S. afrofischeri* and *T. zillii*. River Juma mouth and Dead duck bay stations had the highest number of fish species (12) followed by Lubira and Campsite (10) and lastly Open water station (7). From Dead duck bay station, 10 fish taxa were recorded and they included haplochromines, *B.sadleri*, *L. niloticus*, *T. rendalii*, *O. leucostictus*, *O. niloticus*, *S. intermedius*, *S. afrofischeri* and *T. zillii*. From River Juma mouth, 10 fish taxa were recorded namely haplochromines, *B. sadleri*, *Barbus kerstern*, *Barbus magdalenae*, *Gnathonemus longibarbis*, *L. niloticus*. *T. rendalii*, *O. leucostictus*, *O. niloticus*, *S. afrofischeri* and *T. zillii*. From the campsite 10, fish taxa recorded included haplochromines, *B. sadleri*, *L. niloticus*, *M. grahami*, *T. rendalii*, *O. leucostictus*, *O. niloticus*, *S. intermedius* and *T. zillii*. From Lubira, 6 fish taxa recorded included haplochromines, *B. sadleri*, *L. niloticus*, *O. niloticus*, and *S. intermedius*. Seven fish taxa were recorded from the open water station namely haplochromines, *P. aethiopicus*, *L. niloticus* and *S. intermedius*. Four species of haplochromine cichlids were recorded from Lake Nabugabo and they were *A. velifer*, *G. simpsoni*, *P. beadlei* and *A. alluaudi*. In Lake Nabugabo, distribution of fish varied with species as shown in Table 3. *A. mastercembelus*, *B. magdalenae* and *P. catastoma* were recorded from the shoreline, *T. zillii*, *haplochromines*, and *B. kersternii* were most dominant in the inshore fleet. *S. afrofischeri*, *S. intermedius* and *L.niloticus* were recorded from all stations but were most dominant in the offshore habitat.

Table 2. Fish species occurrence at various sites sampled in Lake Nabugabo between 2000 and 2002 + = encountered, - = not encountered.

Fish species	Campsite	Open water	Duck bay	Lubira	R. Juma
Afromastacembelus frenatus	-	-	+	+	-
Barbus kersternii	+	-	-	-	+
Barbus magdalenae	-				+
Brycinus sadleri	+	+	+	+	+
Gnathonemus longibarbis	-	-	+	+	+
Gnathonemus victoriae	-	-	-	+	-
Haplochromines	+	+	+	+	+
Lates niloticus	+	+	+	+	+
Marcusenius grahami	-	+	-	-	-
Oreochromis leucostictus	+	-	+	-	+
Oreochromis niloticus	-	+	+	+	+
Petrocephalus catastoma	-	-	+	+	-
Protopterus aethiopicus	-	+	-	-	-
Schilbe intermedius	+	-	+	+	+
Synodontis afrofischeri	+	-	+	+	+
Tilapia rendalii	+	-	+	-	+
Tilapia zillii	+	+	+	-	+
Total	**10**	**7**	**12**	**10**	**12**

10 fish taxa were recorded from Lake Kayanja namely haplochromines, *B. kersterni*, *C. gariepinus*, *C. liocephalus*, *G. victoriae*, *M. grahami*, *O. esculentus*, *O. leucostictus*, *P. aethiopicus* and *T. zillii*. Fish species distribution varied with distance from the shoreline as shown in Table 4. Overall the number of fish species decreased with increasing distance from the shoreline. The haplochromine species included *A. alluaudi*, *A. nubila*, *A. velifer* and *P. venator*.

Table 3. Composition, diversity and percentage contribution of various fish species in relation to distance from the shoreline in Lake Nabugabo from 2000 to 2002

Fish species	Inshore	Midshore	Offshore
Afromastacembelus frenatus	0.1	0	0
Barbus kersternii	0.5	0.4	0.4
Barbus magdalenae	0.1	0	0
Brycinus sadleri	19.6	25.5	0
Gnathonemus longibarbis	0	0.1	0
Gnathonemus victoriae	0	0.1	5.5
Haplochromines	46.1	21.7	25.7
Lates niloticus	10.0	12.1	16.0
Marcusenius grahami	0	0	0.1
Oreochromis leucostictus	0.7	0.4	0.4
Oreochromis niloticus	7.4	19.0	3.7
Petrocephalus catastoma	0.1	0	0
Protopterus aethiopicus	0	0	0
Schilbe intermedius	7.5	14.3	39.2
Synodontis afrofischeri	7.1	6.0	7.9
Tilapia rendalii	0.2	0.1	0.4
Tilapia zillii	0.8	0.30	0.8
Total	**13**	**12**	**11**

From Lake Kayugi, 11 fish taxa were recorded and they included *haplochromines*, *B. sadleri*, *B. kersterni*, *C. gariepinus*, *G. victoriae*, *M. grahami*, *O. esculentus*, *P. catastoma*, *O. leucostictus*, and *P. aethiopicus*. Inshore habitats had a higher number of fish species than the open water habitat as shown in Table 4. The haplochromine cichlids included *A. velifer*, *A. nubila*, *G. simpsoni*, *A. alluaudi* and *P. venator*.

Discussion

Results show that most of the native fish species encountered in Lake Nabugabo during the Cambridge Nabugabo biological survey of 1962 have either disappeared or are threatened with extinction. *O. esculentus*, *O. variabilis*, *P. venator* and *Bagrus docmak* were never encountered in Lake Nabugabo during the present study. Among the haplochromines, *P. beadlei*, *G. simpsoni*, and *A. velifer* were the most commonly encountered whereas *H. annectidens*, *A. nubila*, *P. multicolor* and *Astatoreochromis alluaudi* were rare in the catches. *P. venator* was not recorded from Lake Nabugabo. Similar observations have been made in a previous study (Ogutu-Ohwayo, 1993). However, the native tilapine *O. esculentus*, *O. variabilis*, and the haplochromine cichlid *P. venator* that have disappeared from Lake Nabugabo still occur in Lakes Kayanja, and Kayugi. These lakes are thus important refugia for the native fish species that have disappeared from Lake Nabugabo and should be protected for conservation of the endangered native fish species. Satellite lakes have been found to be important in the conservation of species diversity since they can be closed to fishing and monitored more easily (Mwanja *et al.*, 2001).

In the present study, fish species diversity in the Nabugabo satellite lakes was highest in habitats with submerged and fringing macrophytes Numbers of haplochromines, *O. niloticus*, *O. variabilis*, *O. leucostictus*, *T. zillii*, *C. gariepinus* and *P. aethiopicus* were most abundant in near shore areas decreasing outwards towards the open water whereas that of *L. niloticus* and *Synodontis afrofischeri*, were highest in the open water, decreasing towards the near shore areas as shown in Table 3. Fish species diversity decreased with increasing distance from the shoreline, which at all the sites and lakes sampled, was fringed with aquatic macrophytes.

From studies carried out before the introduction of Nile perch, it was observed that the majority of Lake Victoria fishes inhabit shallow inshore waters (Beauchamp, 1955/1956). In the 1989 - 1992 survey it was also found that marginal swamps and rocky reefs were important refugia for indigenous species in Lake Victoria (Kaufman and Ochumba, 1993; Ogutu-Ohwayo, 1993) noted that many surviving species, especially haplochromines, in Lake Nabugabo were confined to macrophytes along the lake margin. In addition, survey of the wetlands surrounding Lake Nabugabo in 1993 to 1994 revealed that several species no longer present in the main lake could be found in the wetland ecotones surrounding the lake (Chapman *et al.*, 1995). Since Lake Nabugabo lacks rocky habitats the key refugia in the lake are inshore habitats with macrophyte cover and wetland areas.

Inshore areas with aquatic macrophytes may serve as both structural and in some cases low-oxygen refugia for prey species from Nile perch. Nile perch are very sensitive to low-oxygen conditions, which may limit their interaction with prey species in hypoxic habitats (Fish, 1956). Chapman *et al.*, 1995 demonstrated that some of the cichlids from Lake Victoria could tolerate extremely low levels of oxygen, which may permit these fishes to use structural inshore habitats as refugia. Submerged and fringing macrophytes also act as barriers to the spread of the Nile perch since the species cannot survive under low oxygen conditions.

Table 4. Percentage contribution of various fish species with distance from the shoreline in lakes Kayanja and Kayugi from 2000 to 2002

	Lake Kayanja			Lake Kayugi	
Species	**Inshore**	**Midshore**	**Offshore**	**Inshore**	**Open water**
Barbus kersternii	5.8	12.4	12.1	0.5	0.6
Brycinus sadleri	0	0	0	0.4	1.0
Clarias gariepinus	2.5	0	0	0.2	0
Gnathonemus victoriae	0.8	0	0	0	0
Haplochromines	7.1	4.5	3.4	5.4	8.8
Lates niloticus	64.4	55.1	60.1	60.3	82.0
Marcusenius grahami	0	0	0	32.8	0
Oreochromis leucostictus	14.0	24.7	17.5	0.2	0.7
Oreochromis niloticus	0	2.2	0	0.1	0
Petrocephalus catastoma	0	0	4.6	0.2	6.6
Protopterus aethiopicus	1.1	0	0	0	0.1
Tilapia zillii	4.7	1.1	1.4	0.5	0.3
Total no. of fish species	**8**	**6**	**61**	**10**	**8**

Conclusion and recommendations

The information gathered so far indicates that marginal macrophytes provide both structural and physiological refugia for the endangered native fish species in Nabugabo lakes. They should therefore be protected for conservation of fish species diversity in these lakes. It has also been observed that lakes Kayugi and Kayanja provide a sanctuary for *O. esculentus*, *O. variabilis* and some of the haplochromine species that have disappeared from L. Nabugabo. These lakes should therefore be protected to reduce further loss in fish species diversity and as a source of brood stock for fish farming.

References

Beauchamp, R.S.A. (1956). The efficient utilization of the fisheries of Lake Victoria. *Ann. Rep. E. Afr. Freshwat. Fish. Res. Org.*. (1955/56)

Chapman J .L; L.S. Kaufman; C.A. Chapman & F.E. Mackenzie (1995). Hypoxia tolerance in twelve species of East African cichlids: Potential for low oxygen refugia in Lake Victoria. *Conserv. Biol.* 9: 1274-1288

Chapman J. L., Chapman A.C., Schofied P.J., Olowo J.P., Kaufman L.S. & Ogutu-Ohwayo, R. (in Press). Biodiversity Lost and Found: Species Resurgence in Lake Nabugabo, East Africa.

Fish, G.R. (1956). Some aspects of the respiration of six species of fish from Uganda. *Journal of Experimental Biology* **35**: 186-195

Kaufman, L.S. (1992). The lessons of Lake Victoria: Catastrophic change in species-rich freshwater ecosystems. *Bioscience*. **42**: 846-858

Kaufman, L. S. (*ed.*) (1993). The challenge of the world's great lakes special section: the great lakes of Africa. *Conserv. Biol.* 7: 445-730

Kaufman, L. S. and **P.Ochumba** (1993). Evolutionary and conservation biology of cichlid fishes as revealed by faunal remnants in Lake Victoria. *Conserv. Biol.* 7: 719-730

Mwanja W., Armouldian A., Wandera S.B., Kaufman L.S., Luzhao W., Booton C., & Fuerst (2001): The bounty of minor lakes: the role of small satellite water bodies in evolution and Conservation of fishes in the Lake Victoria Region, East Africa. *Hydrobiologia* **458**: 55-62

Ogutu-Ohwayo. R., (1993). The effects of predation by Nile perch, *Lates niloticus* on the fish of Lake Nabugabo, with suggestions for conservation of endangered endemic cichlids. *Conserv. Biol.* 7: 701-711